Mirror Image Distal Anterior Cerebral Artery Aneurysms Treated with Coil Embolization

A Report of Two Cases and Literature Review

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Summary

Mirror image aneurysms of the distal anterior cerebral arteries (DACA) are rare. To the best of our knowledge this is the first case report of two patients with mirror image DACA aneurysms treated successfully with coil embolization. The association of aneurysms with anatomic variants has been extensively reported. We may speculate that the remnants of the failed regression of the supreme anterior communicating artery could lead to an increase in stress across their territorial bifurcation, leading to the development of mirror image DACA aneurysms. We found the endovascular treatment of mirror image DACA aneurysms to be feasible and effective. If possible, we suggest the treatment of both aneurysms in one procedure.

Introduction

Distal anterior cerebral artery (DACA) aneurysms have a low incidence, with a mean frequency of 4.4% reported in the largest case series in the literature [1,3-6].

Mirror image DACA aneurysms are rare, with only a small number of patient cases reported to date [16-22].

DACA aneurysms may be derived from an embryologic remnant of the supreme anterior communicating artery, which may cause altered blood flow patterns and hence aneurysms. Embolization of both aneurysms in the same procedure is suitable in cases with subarachnoid haemorrhage (SAH). To the best of our knowledge, this is the first report of the successful treatment of two patients with mirror image DACA aneurysms with coils.

Case Reports

Case 1. A 48-year-old man presented sudden onset of severe headache, vomiting and loss of consciousness and his evaluation according to the Hunt & Hess scale was grade 1. A CT scan revealed a subarachnoid haemorrhage of grade 1 on the Modified Fisher Scale, and CT angiography (CTA) revealed two aneurysms of the pericallosal arteries with domes pressed together. Digital subtraction angiography (DSA) confirmed mirror image aneurysms of both distal anterior cerebral arteries (DACA) (Figure 1). The right aneurysm (sac 4 × 3 mm and neck 2.5 mm) was located at the bifurcation of the pericallosal and anterior frontal arteries and was orientated anteriorly. The left aneurysm (sac 6 × 5 mm and neck 2 mm) was located at the bifurcation of the pericallosal and callosomarginal arteries and was also orientated anteriorly. No vasospasm was noted.

Endovascular coil embolization of both aneurysms was performed whilst the patient was under general anaesthesia and systemic heparinisation (2500UI). A Headway 17 Advanced microcatheter (MicroVention, CA, USA) was deployed after placing a Chaperon 6F guide catheter (MicroVention, CA, USA) first into the left, and subsequently into the right internal carotid arteries. Six platinum coils (Microplex-helical, MicroVention, CA, USA)

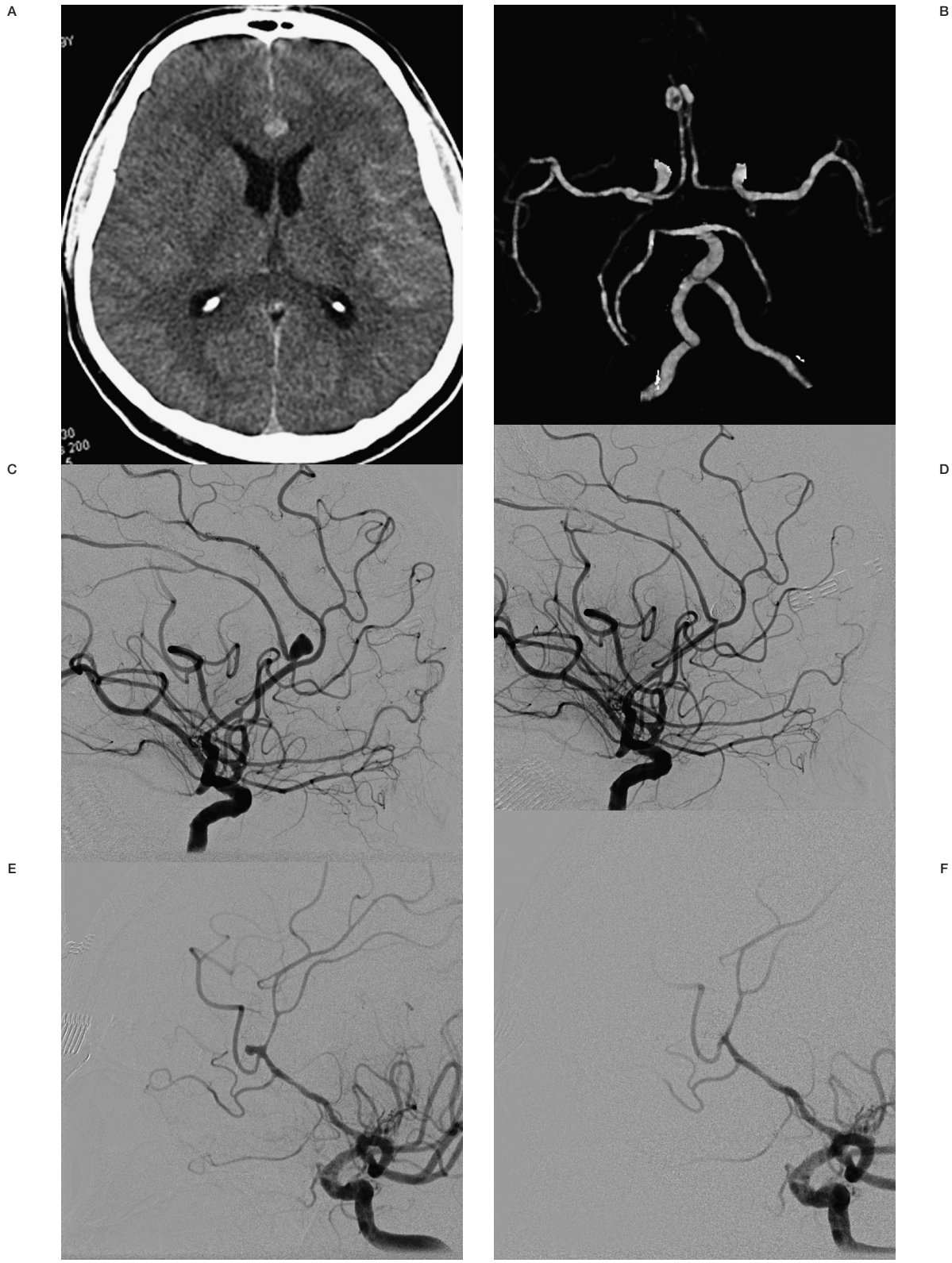

Figure 1 A) Head CT, evidence of SAH in the anterior interhemispheric fissure. B) CTA revealing mirror imaging of both DACA. C) DSA, left sided pretreatment aneurysms and D) post endovascular treatment. E) DSA, right sided pretreatment aneurysms and F) post endovascular treatment.

were used to occlude the left-sided aneurysm, and three coils (Microplex-helical soft, MicroVention, CA, USA) were used to occlude the right-sided aneurysm.

A satisfactory occlusion grade of 95% was thereby achieved for both aneurysms without complications. The patient was discharged within seven days in full recovery with a clinical outcome on the modified Rankin Scale (m-RS) of 0.

Case 2. A 40-year-old woman presented with sudden onset of headache and loss of consciousness. Her GCS was 12 out of 15, and clinical evaluation according to the Hunt & Hess scale was grade 2. A CT scan revealed an interhemispheric haematoma. This was recorded as grade 4 on the Modified Fisher Scale. The CTA revealed and DSA confirmed two mirror image DACA aneurysms. Both DACA aneurysms on the right (sac 6 × 3 mm and neck 2.5 mm) and left (sac 3 × 2 mm and neck 2 mm) were located at the bifurcation of the pericallosal and callosomarginal arteries and were orientated anteriorly (Figure 2).

Vasospasm in the adjacent arteries was noted without circulatory delay. The embolization procedure was performed whilst the patient was under general anaesthesia and systemic heparinisation (2500UI). A Headway 17 Advanced microcatheter (MicroVention, CA, USA) was used after placing a Chaperon (MicroVention, CA, USA) 6F guide catheter into the right internal carotid artery. Superselective injection of Verapamil (5 mg) diluted in 50 ml of saline was administered during 30 min before catheterization of the aneurysm. Four platinum coils (Microplex-helical, MicroVention, CA, USA) were used to occlude the right-sided aneurysm.

The second aneurysm was treated six days later under general anaesthesia and 5000 UI of heparin bolus. Using a 6F guide catheter in the left ICA, the aneurysm was catheterized with a Headway 17 Advanced microcatheter and Traxess-14 microwire (MicroVention, CA, USA).

One coil (2 mm × 40 mm, Microplex-helical soft, MicroVention, CA, USA) was used to occlude the left-sided aneurysm.

Although a small part of the coil protruded into the callosomarginal artery, the treatment was completed without complications and the patient was discharged in full recovery with a clinical outcome on the Modified Rankin Scale (m-RS) of 0.

Discussion

Aneurysms distal to the anterior communicating artery are commonly called pericallosal artery aneurysms. However, since they may originate from the callosomarginal artery, or A3 and A4 branch vessels, it is appropriate to group them as distal anterior cerebral artery (DACA) aneurysms [1,2]. DACA aneurysms have a low incidence, with a mean frequency of 4.4% reported in the literature [1,3-6]. Mirror images of DACA aneurysms are rare [16-22].

Mirror image aneurysms of the supreme anterior cerebral communicating artery. The association of aneurysms with anatomic arterial variations is well-known, and a 25-40% incidence of anatomic variations in the anterior part of the cerebral arterial circle has been reported [7]. The supreme anterior communicating artery was first described by Latinen and Snellman (1959) as a communication between the two pericallosal arteries at their major branches. They suggested this connection may be a remnant, and could be the aetiology of aneurysms at this site [3,4]. To understand the variant of the supreme anterior communicating artery we have to consider all anterior cerebral artery (ACA) variants. When describing the ACA variants in their different territories, specific embryological features must be recalled. The development of the corpus callosum creates a bridging structure between the two hemispheres. As commonly observed in other regions, a bridging structure allows arteries to supply both sides, and this characteristic creates additional variants, in particular the so-called median artery of the corpus callosum, or the accessory anterior cerebral artery (AccACA) [8]. The origin of the AccACA is a matter of debate. Some authors [8] support the theory that this artery is not an embryonic artery which has regressed, but rather an attempted fusion of paired arteries located in the midline. Such a process cranially prolongs the changes achieved with the basilar artery and anterior spinal axis. Other authors support Padget's theory [7,9,10] describing the embryogenesis of the anterior cerebral arterial circle as the result of two important stages: firstly, the development from the cranial division of the internal carotid artery (ICA) of numerous arteries supplying the anterior part of the brain; secondly, the in utero regression of certain arterial segments, and in some cases during ex utero development into adulthood [7,9,10]. The embryological cerebral an-

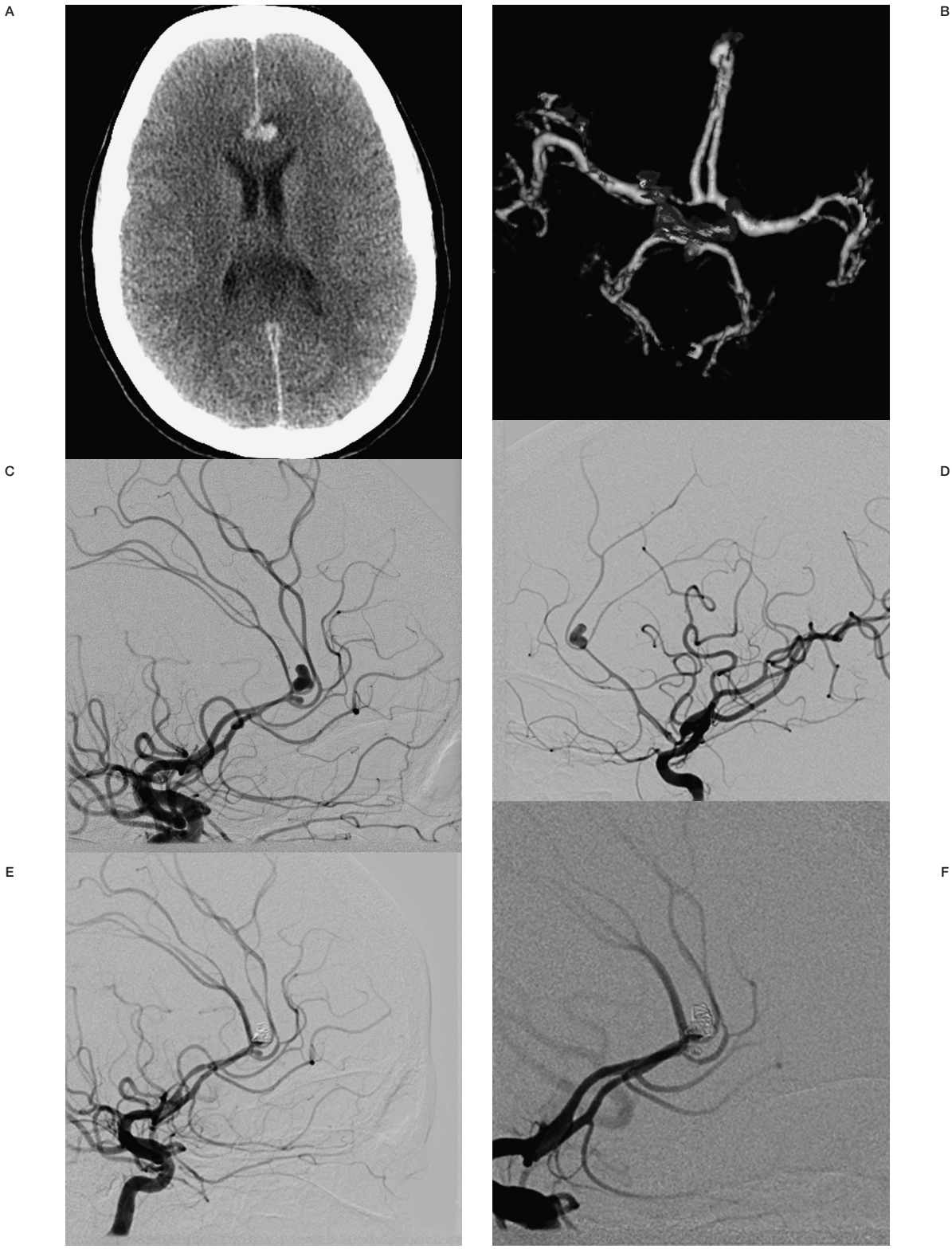

Figure 2 A) Head CT, evidence of the anterior interhemispheric hematoma. B) CTA revealing mirror imaging of both DACA. C) DSA, injection in the left ICA showing both mirror DACA aneurysms. D) Injection in the right ICA showing the right-sided aneurysm. E) DSA, left ICA injection, occlusion of the right-sided aneurysm. F) DSA, left ICA injection, occlusion of both aneurysms.

terior circle, which is more developed than in adults, has three anterior cerebral arteries and an anterior communicating plexus. The third anterior cerebral artery is known as the median artery of the corpus callosum. The anterior communicating plexus and the median artery of the corpus callosum should regress; failure to do so can lead to numerous anatomic variants such as an AccACA, due to the persistence of the median artery of the corpus callosum, or double anterior communicating artery (ACoA) due to incomplete regression of the anterior communicating plexus. It is believed that variations or anomalies in the arteries of the cranial circulation lead to increased blood flow, which in turn increases the stress across their territorial bifurcation leading to the development of aneurysms [11]. Therefore, an abnormal flow pattern is encountered at the embryologic remnant of the supreme anterior communicating artery, which is predisposed to the development of mirror DACA aneurysms.

Yasargil and Carter [1], in a study of 13 patients with DACA aneurysms treated with microsurgical techniques, found two cases where the aneurysmal sacs were connected (visualised during surgery). They suggested that, although a developmental aetiology is possible, it is as likely that some unusual anatomical variation, such as a supreme ACoA, may cause a flow disturbance leading to aneurysm formation [1,12,13]. Casimiro et al. reported that risk factors differ between mirror image aneurysms and other types of multiple aneurysms, noting that the former were diagnosed in relatively young patients. They hypothesized that patients with mirror image aneurysms may have a localised congenital predisposition to vessel fragility or vascular wall defects, which may lead to early rupture in the absence of other risk factors [14]. Allegre and Vigouroux suggested that aneurysms in pericallosal arteries are located predominantly at the bifurcation of the pericallosal and callosomarginal arteries. If the callosomarginal artery is not coherent, the aneurysm lies at the bifurcation of the pericallosal and anterior frontal artery [4,15]. This could explain the finding in our first case where the left callosomarginal artery was not coherent. In another case reported by Handa and Suzuki, the two pericallosal arteries converged at the site of the aneurysmal neck where multiple peripheral branches emerged. During surgery, they confirmed that a supreme ACoA facilitated the communication between the DACA segments

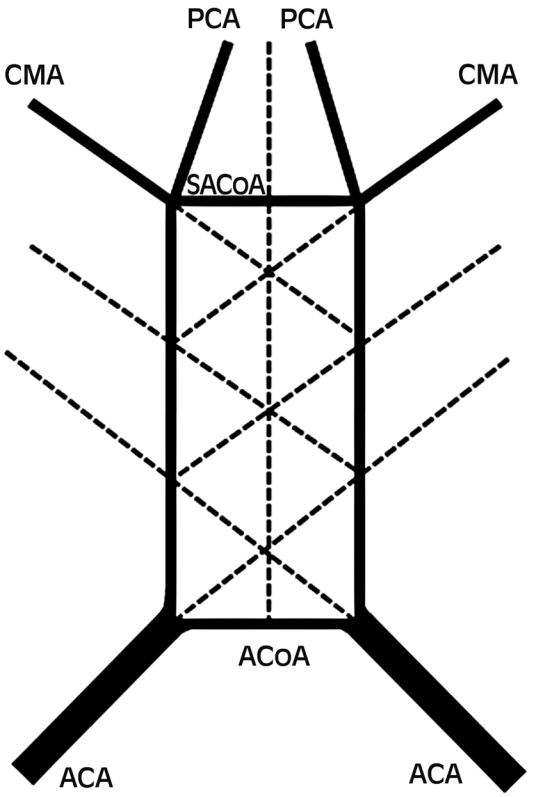

Figure 3 Scheme of the variant with the supreme anterior cerebral communicating artery. The embryological arteries and anterior communicating plexus are also shown with dotted lines. ACA: anterior cerebral artery; ACoA: anterior communicating artery; SACoA: supreme anterior communicating artery; CMA: callosomarginal artery; PCA: pericallosal artery.

[16]. Wisoff and Flamm [17] reported bilateral symmetrical aneurysms in two out of 20 cases. Mori et al. interpreted these bilateral DACA aneurysms in mirror image position as kissing aneurysms, as magnetic resonance revealed that the aneurysmal sacs were connected. Kissing aneurysms are defined as two aneurysms of different origin with their domes pressed together [18,19]. Albert et al. [20] described a rare case of a ruptured pericallosal aneurysm originating from an atypical communicating segment between both distal A2 arteries, called "the supreme anterior communicating artery". In summary, mirror imaging of DACA aneurysms is rare; they are a specific type of aneurysm which may be derived from an embryologic remnant of the supreme ACoA, which may be the cause of altered flow patterns and hence aneurysms. We could speculate that the supreme ACoA is a failed regression of the anterior communicat-

ing plexus at the level of the A2-A3 segments (Figure 3).

Therapeutic aspects. Clinical presentation of ruptured DACA with typical sudden onset of a severe headache is not unusual. The site of the aneurysm is associated with different characteristics. They often present with intracerebral haematoma and have a tendency to rupture before they become large [22]. CTA is a useful tool to confirm the origin of bleeding and evaluate the presence of mirror image aneurysms before additional treatment planning. It is important to ensure that this area is included in the image volume, as it is easily excluded by low placement or low angulation of the planning block. We have found the use of routine MR in cases with subarachnoid haemorrhage to be reduced, due to problems associated with patient movements. We consider CTA to be more accurate in the detection of mirror pericallosal aneurysms. However, we use MR angiography (MRA) extensively in the follow-up of patients with coiled aneurysms. Whilst MRA resolution is poor in comparison with DSA, it is possible to visualize significant coil compaction or aneurysm recurrence which may require re-treatment.

DSA remains the basis of diagnosis and treatment planning. In many centres, endovascular treatment has become the method of choice for the treatment of intracranial aneurysms, while the International Subarachnoid Aneurysm Trial broadly concluded that there was a benefit of treating ruptured anterior circulating aneurysms in an endovascular fashion [23]. The value of endovascular embolization in general use, and in most locations, is well-established. However, its value in rare conditions, such as mirror aneurysms of pericallosal arteries, has yet to be elucidated. Only a small number of studies addressing the efficacy of endovascular treatment for distal ACA aneurysms have been published, and studies comparing endovascular and microsurgical repair in anterior circulation aneurysms occurring at specific locations also are lacking [2,24,25].

Historically, pericallosal aneurysms have more frequently been treated surgically, with a greater number of case series documenting the feasibility of microsurgical treatment compared with endovascular approaches. However, microsurgical case series have highlighted several significant difficulties in the treatment of pericallosal aneurysms from an open approach, with the results of treatment proving to be significantly worse than in proximal ACA and ACoA aneurysms. The space between two hemispheres is narrow, which limits the surgical exposure, particularly in a swollen brain after SAH. For adequate surgical exposure, it may be necessary to sacrifice a bridging vein, which increases the risk of postoperative morbidity. These difficulties are more apparent when dealing with ruptured lesions, and with aneurysms more proximal in relation to the rostrum of the corpus callosum. As a consequence, surgical morbidity has been reported to be relatively high, with an incidence ranging from 0% to 25% [1,4-6,12].

The evolution of modern endovascular techniques now allows the treatment of a greater percentage of distal ACA aneurysms, and may provide better outcomes for patients. We treated both patients in the case studies by an endovascular approach, following consultations with neurosurgeons. In the first patient both aneurysms were treated at the same time, while in the second patient the aneurysms were intentionally treated on two separate occasions. To the best of our knowledge, this is the first report of the successful treatment mirror image DACA aneurysms in two patients using endovascular coils.

Conclusion

Mirror imaging of DACA aneurysms is rare, and may be derived from an embryologic remnant of the supreme ACoA, which may be the cause of altered flow patterns and hence aneurysms. All patients with DACA aneurysms should be evaluated carefully using DSA to determine the presence of additional aneurysms. In this case series, endovascular treatment of mirror image DACA aneurysms was technically feasible and successful. Embolization of both aneurysms during the same procedure is suitable, if possible, in patients with SAH.

Acknowledgments

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